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REPORT OF THE HYDRAULIC STUDIES ON THE SAN DIEGO RIVER, SAN DIEGO COUNTY, CALIFORNIA.

By C. S. Alverson.

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R E P O R T

of the

HYDRAULIC STUDIES

on the

SAN DIEGO RIVER

SAN DIEGO COUNTY, CALIFORNIA

By C. S. ALVERSON,

Hydraulic Engineer.

August 17, 1914.

(See amended report of
December 14, 1914
for quantities)

INDEX TO REPORT

+ For quantities see report of December 14, 1914.

REPORT OF C. S. ALVERSON, HYDRAULIC ENGINEER

TO THE WATER DEPARTMENT, CITY OF SAN DIEGO, CALIFORNIA,

UNDER ORDINANCE 5051 WATER CONSERVATION BOND FUND

SUBJECT: HYDRAULIC STUDIES OF THE SAN DIEGO RIVER, SANDDIEGO COUNTY, CALIFORNIA.

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Honorable H. R. Fay, Superintendent,
Department of Water,
City of San Diego, California.

Sir:

The following report is compiled from personal and official hydraulic studies on the San Diego River and its branches in San Diego County, California, and covering the period July, 1886 to the present time, viz: August 1914.

Was employed by the San Diego Flume Company from July 1, 1886 continuously to April 1888. From that period to the present time I have frequently made examinations and submitted reports to them and their successors.

In 1901-02 and 1905-06 was Superintendent of the Water Department of the City of San Diego, and as such familiarized myself with the water conditions in Mission Valley and elsewhere.

In 1904-05 made examinations and submitted reports to the City of San Diegounder provisions of Ordinances Nos. 1780 and 1815, which are on file in the City Clerk's Office.

In July, 1912, made examinations and submitted a report to the riparian owners along the San Diego River on the "Underground Water Supply of the San Diego River."

I have made other examinations along the river and its various branches for other parties in connection with the installing of pumping plants and irrigation enterprises of various kinds.

GENERAL DESCRIPTION.

The San Diego River has several branches. The principal ones are North Fork, or Coleman Creek, which heads in Section 4, T 13 S, R 4 E, about one and one-half miles SE of the town of Julian. It runs in a northwesterly direction on through Spencer Valley and then turns abruptly to the southwest and runs for several miles through a rocky and wooded canyon.

Cedar Run heads in Sections 15-16-22, T 13 S, R 4 E, and runs in a westerly and southerly direction and joins the North Fork near the corner to Sections 1-2-35-36, T 13-14 S, R2E. Boulder Creek heads to the East of the three high peaks of the Cuyamaca Mountains and the upper twelve square miles of drainage is the source of supply for the Cuyamaca Reservoir. Commencing at the Cuyamaca Dam with an elevation of the stream bed of approximately 4550 feet above sea level it runs a little N of W for about two and one-half miles; thence nearly south for one and one-fourth miles; thence westerly for about eight miles and joins the North Fork 1360 feet S 25° W from the corner to Sections 1-2-11-12 T 14 S, R 2 E, elevation about 825 feet above sea level. The sides of the canyon are steep and abrupt.

NOTE: From survey made by the writer October 6, 1887, I note the following data that may be of future use:

Connecting Diverting Dam with U. S. Land Survey

From Cor. to Secs. 1-2-11-12 T 14 S, R 2 E

I ran true Course Va 13 degrees 30' E

S 24 degrees W at 1350 feet, cross Boulder Creek 10 feet left of wagon road at 1800 feet end of course; thence S 10 degrees 15' W 1406 feet to North side of head gate of Diverting Dam, making diverting dam 3028' south and 982 feet West of corner to Sections 1-2-11-12, T 14 S, R 2 E.

From the Diverting Dam the river flows in a West and Southerly direction; about two and one-half miles below Sand Creek joins it from the East, and at six and one-half miles the South Fork from the East joins the North Fork about 600 feet North of the 1/4 corner to Sections 9-16 T 15 S, R 2 W. The junction of these two streams forms the San Diego River proper. The South Fork heads to the West of the Cuyamaca Mountains and is formed by the junction of Cenejos and King Creeks in Section 6, T 15 S, R 3 E, and flows Westerly for about four miles where it joins the North Fork as above described. About one and one-fourth miles below the junction of the North and South Forks, Chocolate Creek joins from the South near the center of Section 8. Chocolate Creek heads near Alpine Heights and is about five miles in length.

From Chocolate Creek the river flows a little North of West for two and three-fourths miles to Cape Horn point; thence Southwesterly to a point about 500 feet below the crossing of the Cuyamaca Railway where San Vicente Creek joins it from the North. San Vicente Creek heads to the South of Ballena Valley and has several branches and in all probability was the ancient

bed of the Old San Diego River.

About one-half mile below the San Vicente Creek junction Los Coches Creek joins from the South. Los Coches Creek heads in Section 24, T 15 S, R 1 E.

From the junction of Los Coches Creek the river flows in a West and Southerly direction through the North El Cajon Valley to the Old Mission Dam, located some 800 feet East of the West boundary line of El Cajon Grant, and at the head of the gorge above Mission Valley.

The Old Mission Dam was constructed by the Mission Fathers about 1776. Also the aqueduct from the dam to the Mission, about five and one-half miles in length, was constructed at the same time, and is a remarkable example of what the Mission Fathers did for civilization with the crude and primitive assistance at their command.

From the Old Mission Dam the River flows through the gorge a distance of two and one-half miles to the upper end of Mission Valley; thence down Mission Valley for about three miles where Alvarado Canyon comes in from the East; thence for about six and one-half miles it flows down the Mission Valley to the Bridge at Old Town. From the Bridge at Old Town it flows across the flats into False Bay where it's waters mingle with the Pacific Ocean.

Alvarado Canyon (North Branch) heads to the South-east of Cowles Mountain and some three miles below is located the La Mesa Dam, which is a part of the Cuyamaca Water System. The reservoir is used for storing the surplus water brought

down in the flume during the flood season of the San Diego River, and is an important factor in the proper conserving and utilization of the flood waters of the San Diego River.

SAN DIEGO RIVER GEOLOGICAL FORMATION.

In the study of Surface and Underground Water Supplies the geological formation and structure often becomes an important factor in determining the amount of the available water supply of the section investigated.

The following is an outline of the geological formation along the San Diego River.

Point Loma forms a peninsula, the greatest length of which is about six miles and the greatest breadth one and one-half miles. During Quaternary times it was an island, but owing partly to an elevation of the coast, and partly to the detritus brought down by the San Diego River, it became joined to the mainland. The rock of which it is formed consists of soft shales and sandstones.

The region occupied by San Diego Bay and the mesa back of it is composed, as far as we know, of Quaternary Pliocene and perhaps Miocene strata. Sandstones and shales characterize the lower formation, and loosely cemented conglomerates, increasing in thickness toward the mountains, the upper. These were deposited in a sort of basin, of which Point Loma and the Soledad hills formed the Northern and Western borders. (See log of Balboa Well)

The first outcrop of crystalline rocks in Mission Valley is about three miles above the Old Mission, where the San Diego River enters a canyon. It is a volcanic tuffa, consisting of grayish to greenish fragments of a fine grained rock imbedded in a brown matrix. this has a width of about one-half a mile. Along the canyon dikes of a greenish anygdaloid have been intruded in the rock. Farther up the canyon there is a great variety of tufas. The contain feldspatic and hornblendic fragments, crystallized feldspar chloritic particles and micaceious fragments. These rocks occupy the canyon for one and one-half miles and are all undoubtedly of volcanic or intrusive origin. The tuffs exposed at the mouth of the canyon extend in a direction a little East of South for three miles, until covered by the means which extend West from Mi&ajon. The ridge which these rocks form is separated from the granite by an elevated mesa a mile wide. The ruffs are exposed along Alvarado Canyon to within two miles of the Mission.

The granite ridge at the Old Mission Dam does not extend more than two miles North; when it becomes covered with bedded deposits and boulders of late Tertiary age. Granite does not appear in Sycamore Canyon until the Northeast boundary of the Cajon Grant is reached. High hills of gravel and boulders lie east of the canyon and extend towards Foster's.

Granite rock are the only ones exposed for many miles East of Lakeside.

The three Cuyamaca peaks are a dark basic rock ranging from fine to a very course texture.

The geological formation of the San Diego River and its branches may be described as follows;; The higher mountains are formed of ancient crystalline schists and massive rock. Lower down eruptive rock has been intruded. The region bordering on the coast consists of conglomerate deposits of unknown depth. The frequent foldings and uplifts have formed spurs and knobs; and these changes in the earth's surface in turn have formed valleys and trough-like depressions into and through which the modern river has cut its way in its flow to the ocean. The denuding and erosion of the hills and the detritus brought down by the river during the floods have filled these depressions to a greater or less depth with silt, sand, gravel and boulders, and formed underground storage reservoirs. These reservoirs conserve the water in the rainy season and equalize the flow throughout the year. These underground reservoirs, together with the surface run-off of the watershed, forms your source of supply.

What the geological formation is under the riverbed and under these storage basins is an unknown quantity, but it is certain that the foldings, and intrusion of dykes, and other geological changes, has left voids and fissures into and through which the surface waters find their way.

These conditions determine to a greater or less degree on different streams the economical location of the underground and surface storage basins.

LOSS OF WATER IN STREAMS

The loss of water in a stream is often the controlling factor in determining the proper location and method of conserving and utilizing the run-off from the watershed under consideration.

The following illustrations of this principal may be of use to you in arriving at a proper solution of the San Diego River water supply.

Rio Penasco heads in the Sacramento Mountains (New Mexico) bringing down not less than 150 to 200 second feet. It formerly disappeared before it hardly left the mountains. Now it is a running stream its entire length to junction with the Pecos River, after considerable has been used for irrigation. The cause of this is that for about ten miles a new channel or canal was dug where formerly it sank. Also cattle that came to drink (12,000 to 15,000) daily trammed the bed of the stream and made it impervious. The formation is limestone underlaid with a conglomerate of gravel and boulders and same imbedded in matrix of lime and sand.

Black River, as it is called, (in Southern New Mexico) is nothing but a storm-water channel into which four springs discharge and soon sinks if it is not taken out for irrigation. Three of these springs discharge 5 cubic feet per second each and Blue Spring, the lower one, 17 cubic feet, a total of 32 second cubic feet.

The upper Rio Hondo is formed by two mountain streams,

viz: the Rio Ruidosa and Rio Bonito. The water rapidly diminishes in volume as it leaves the mountains and is lost entirely before it gets out of the foothills.

In the vicinity of Roswell (New Mexico) is a spring which forms the North Spring River. Volume 105 sec. ft. two miles below its source. This joins the Rio Hondo just before it enters the Pecos River.

The flow of the Pecos River at Eddy (New Mexico) is 1000 sec. ft. of spring water and 500 sec. ft. of surface water After the dam was built and gates closed for several days; dam tight and no water passing it, the stream was measured seven miles below, and over 300 sec. ft. and come into the stream from springs in the bottom and along the sides.

The Missouri River between the Great Falls and Fort Benton (Montana) a distance of about 30 miles, looses 834 sec. ft., or the equivalent of 41700 miner's inches continuous flow. The Benton shales beginning about five miles above Fort Benta mark the head of navigation and the point where the "Big Muddy" becomes colored by erosion. About eight miles above the Great Falls is the Giant Springs in the channel and on the right bank. The flow is about 638 sec. ft. or 31900 miner's inches. The strata or rock around the springs for 50 or 75 feet is broken up like the result from a heavy charge of Giant powder.

The Arkansas River near Great Bend and Larnard, Kansas, is often nearly dry on the surface for several months.

Quinn River, in Northeastern Nevada, is formed by

several good sized streams from the mountains to the West. The united waters of these streams make a large river that fllws southerly and is entirely lost on the surface in the Quinn River Desert below.

Susan River in Lassen County, California, heads in the high mountains, its source being lakes of living water formed and constantly replenished by the melting snow. After flowing in a rocky bed for a few miles it enters a mountain valley of loose porous sand and gravel and sinks for three or four miles during the summer and fall. Below the stream again becomes perpetual and the volume of water is increased by springs from the sides and other branches independent of its source.

Sweetwater River (San Diego County) whose 185 square miles of watershed is the source of supply for the Sweetwater Reservoir; for several seasons during the last 25 years has furnished no surface runoff that reached the reservoir, although water was flowing on the surface at Jamacha and other points in the river bed above.

Cottonwood Creek (San Diego County) and its branches, which is the main present source of supply for the City of San Diego, also loses its surface waters in the sands and gravels along the channel of the streams. Of the water released from the Morena Reservoir in the month of April over 40 per cent was lost before reaching the intake about one and one-half miles above Barrett Dam. In all probability the greater part was lost in the upper four miles.

San Diego River (San Diego County) the stream that

is the subject of the hydraulic studies embraced in this report, also shows that similar conditions prevail along its channel.

Sometimes the normal flow of a stream is lost or diverted from the regular channel by intercepting dykes or banks or more or less impermeable material; and the water finds its way into the underground channels of ancient rivers whose beds ran diagonally or at right angles to the present stream.

EXAMINATION OF THE SAN DIEGO RIVER IN THE YEAR 1894.

In June, 1894, I made an examination of the San Diego River bed for the San Diego Flume Company. This was a dry year and they were considering the advisability of pumping water from the bed of the river up into the flume for a temporary supply.

Beginning at the diverting dam located near the 1/4 corner to Sections 11 and 12 T 14 S, R 2 E, just below the dam about 5 miner's inches was running on the surface, which disappeared a short distance below.

At Charles Hensley's place, about 4 miles below, there were a few miner's inches of water running on the surface.

At the junction of South Fork and the main river there was no water on the surface, but just below where the low water channel comes close to the bluffs on the left bank of the river a small stream of water rose to the surface.

At the junction of Chocolate Creek with the main river no water showed on the surface, although one mile up

the Chocolate Creek where the flume line crosses there was about 12 miner's inches running on the surface.

From Chocolate Creek to the Cape Horn tunnel some water in the spring branches from El Cajon Peak.

From the Cape Horn Tunnel to the Monte tunnel the river bed and bottom lands widen and water appeared on the surface at different points.

EXAMINATION OF THE SAN DIEGO RIVER IN THE YEAR 1898.

In the summer of 1898 the Monte Pumping plant, located about one and one-half miles above Lakeside, was established and commenced pumping into the flume July 21, 1898. On November 22, 1898, I examined this plant and copy from my notes taken at that time. The pump is high duty, horizontal direct acting, water plungers 12 in. diameter. Fuel wood and crude oil. The water is obtained from 24-2 in. dia. drive wells, connected with a suction main 3, 6, 8, 10 in. dia. Water is forced up the hill (about 300 foot lift) to a point about 1/4 mile distant from the Monte tunnel, thence conveyed in a flume 20 inches wide to the east approach of tunnel. They were pumping about 1170 gals. per minute, or 1,684,800 gals. per 24 hours. (Note: Later the El Captain auxiliary plant was put in.)

On the following day (Nov. 23, '98) continued my trip up the San Diego River. About 1/4 mile below mouth of Chocolate Creek 5 miner's inches running on the surface. Also near the Indian School some water running in the channel

Just below the diverting damabout 2 miner's inches running on the surface. At Lake Helena dam site (about 1½ miles above the diverting dam) in the two shafts sunk at site the water was within eight feet of the surface in bed of stream. (the North Fark) The 18 miles of the San Diego Flume from the diverting dam to the Monte tunnel is absolutely dry. No water.

In November, 1904, I examined the above referred to Monte pumping plant which had been overhauled and changed, and at that time consisted of the following equipmentL 4 open wells or circular shafts about 200 feet apart sunk in the sands of the river bottom 20 feet in depth and 15 feet in diameter, and four 8 in. diameter galvanized iron casings put down in the bottom of these shafts to an additional 50 feet or a total of 70 feet in depth. Water level when not pumping 26 feet Below general surface of ground and about 36 feet when pumps are running. Water is raised from the wells by two 25 HP, one 14 HP and one 10 HP gas engines; and two 6 inch and two 5 inch centrifugal pumps into a settling tank; and thence raised 300 feet elevation into a flume by two Snow steam pumps. On December 12, 1904, about one month later, I again visited the plant; they were pumping at the rate of about two million gallons per 24 hours and claimed to have pumped during the summer months from 3½ to 4 million gallons per 24 hours.

AMOUNT OF WATER DELIVERED TO SAN DIEGO FLUME
BY MONTH AND CAPITAN PUMPING PLANTS.

Year	Total Acre-feet	Total Million gals
1898	630.5	205.45
1899.	1270.	413.83
1900	1871.	609.66
1901	648.	211.15
1902	657.	214.08
1903	853.	277.95
1904	1278.	416.43
1905	00.	00.00
1906	36.5	11.90

EXAMINATION OF THE SAN DIEGO RIVER
IN 1904 and 1905.

In November and December of 1904 and January of 1905 I personally made an examination and submitted reports of the river bed and channel from the Old Mission Dam to Lakeside for the City of San Diego, with reference to the water supply.

The field notes, drawings, maps, reports, etc. are on file in the City Clerk's office under head of "El Cajon Valley Water Investigation, by C. S. Alverson, C. E. "

The following is a synopsis of the examination: The testing apparatus was a derrick and 4-inch sand pump operated by hand power. This should have been machine operated so that greater depth could have been obtained in order to have made a complete investigation.

That wells 12 in number were sunk in and near the channel of the river, the existing pumping plants examined and tested, with the following general results: In the test wells the water surface was from four to eight feet below the general

surface of the ground. The test wells were sunk from 25 to 30 feet in depth and good water bearing sand and fine gravel found. The following log of test well No. 7 is a fair average of results First 4½ feet soil, silt and fine sand; then 3 feet of coarse sand; water found at 7½ feet below the surface, then 21½ feet of coarse sand and some fine gravel, a total of 29 ft. and good material in bottom of well. This well is located on first bench above low water channel of San Diego River (See Diagram)

No test wells were sunk in the Fanita Ranch.

EXISTING WELLS AND PUMPING PLANTS 1904.

At the Williamson ranch house, one fourth of a mile north of Santee Station on the Railway, the well is a 10-inch casing drive well, reported to be 70 feet in depth and to have passed through silt and sand the entire depth and bottom of well, still in sand. At time of examination November 10, 1904, the water stood 11½ feet below the surface. July 23, 1912, it was 8½ feet below he surface, or 3 feet higher.

In 1894 the San Francisco Savings Union bored six 10 inch drive wells in the channel of the San Diego River near Riverview Station on the Cuyamaca and Eastern Railway. These wells are designated as A-1-2-3-4-5-6. Wells A-1-2-3-4- are about 200 feet apart, and are located in a direct line between the two rocky hills that narrow the valley at his point. The course of the line is approximately N 37° W. Wells A-5-6 are located farther up stream above the right bank of the low water channel of the river. (see diagram)

In all six wells the stratas passed through were practically the same, viz: The first 50 feet sand, gravel, etc., water bearing, then 30 feet of loosely consolidated conflomerates through which the water would slowly percolate, then six feet of very coarse gravels and cobblestones free from fine sand or silt and good water bearing; then for a few feet through a fine grained material; no bed rock found. After the wells were completed a test was made at Well A-6 with an engine and 4-inch centrifugal pump. (Note: The suction pipe extended down only 18 feet below surface. Should be 35 feet.) The result after several hours pumping with the water lowered to near the end of the suction was about 270 gallons per minute, or 388,800 gallons per 24 hours. The floods of 1895 entirely covered up wells A-2-3-4, and partially filled wells A-1-5-6 for the reason that the caps on the wells had not been properly secured.

November 22, 1904, I personally made the following measurements:

Well A-1 water 3½ feet below surface and 57 feet in depth
Well A-5 " 3½ " " " " 72 " " "
Well A-6 " 4.0 " " " " 68 " " "

Note: July 6, 1912 water surface in well A-6 was 5.67 feet below top of casing or 3.83 feet below surface of ground, which is practically the same as November 22, 1904.

J. R. GILLIN PUMPING PLANT
EXAMINED NOVEMBER 12, 1904.

Located about 1½ miles N and W of Santee Station on bench above left bank San Diego River. Open curbed well 24 feet in depth. Water 13 feet below surface when not pumping Equipment: 8-inch suction pipe extending down into well, a 4-inch

Sterne centrifugal pump, a 10 HP West Coast Gas Engine. Engine revolutions 255 PM. Pump revolutions 618 PM. After two hours pumping water lowered 9½ feet and remained stationary. Pumping 600 gallons PM or 864,000 gallons per 24 hours.

H. D. WILLIAMSON'S NORTH SIDE PUMPING PLANT
EXAMINED NOVEMBER 9, 1904.

Located about 4000 feet north of Santee Station on the north side of the river channel proper (See diagram) It consists of four 8-inch drive wells in which are placed 6-inch diameter Cook well points, length of perforation 8 feet.

1st well located at the pump and 30 feet in depth
2d " " 20 feet from 1st well, 40 feet in depth
3d " " 24 " " 2d " 40 " " "
4th " " 50 " " 3d " 40 " " "

Wells are attached directly underneath to a 7-inch suction pipe, a 20 HP Model Gas Engine and a No. 5 Sampson pump. After nine hours continuous pumping as follows:

Water 20 feet below surface of ground
Water 17½ " " 7-Inch suction pipe
Estimated discharge 600 gals. PM or 864,000 gals. per 24 hours.

H. D. WILLIAMSON'S SOUTH SIDE PUMPING PLANT
TEST MADE NOVEMBER 12, 1904, at 4 P. M.

Located about one-half a mile northeasterly from the Santee Station on the south side of the river channel proper. It consists of four 8-inch drive wells in which are placed 6-inch diameter Cook's well points, length of perforation 8 feet.

1st well is located at the pump and is 37 feet in depth
2d w " " " 25 feet from 1st well and is 35 feet in depth
3d " " " 30 " " 2d " " "31 " " "
4th " " " 50 " " 3d " " " 40 " " ""

Wells are attached directly to a 7/8 inch diameter suction main. A 20 HP Lambert Gas Engine and a No. 6 Sampson centrifugal pump. Engine revolutions 180 P. M. Pump revolutions 465 P. M.

Water raised 8½ feet above the center of pump into a 12 x 13 inch flume, inside measurement. Flume rinning full. After eight hours continuous pumping the estimated discharge was 1170 gallons PM or 1,684,800 gallons per 24 hours.
(Note: This discharge seems high for a No. 6 centrifugal pump, but the measurements were made in the flume with floats and should be fairly correct.)

MRS. F. M. MCKOON'S NEW WELL
EXAMINATION MADE NOV. 10, 1904

Returning to the lower end of the area included in this investigation and west and south of Sycamore Canyon Mrs. F. M. McKoon was putting down some wells. The first well was some distance from the river and decomposed granite was struck at a few feet below the surface. A second well (that they were just completing) and located 650 feet west of the Sycamore Canyon road and about 400 feet south of the left bank of the river. This well showed the following results from personal examination: first 9 feet soil, sand, gravel and some cobble-stones; water found at 9 feet below surface; then 18 feet of sand, cobble-stones and water bearing material; then 8 feet of compact blue clay, a total of 35 feet in depth. The strata of blue clay was not penetrated and is of unknown depth.

The large lagoon just north of the McKoon ranch house (now E. W. Scripps) is reported to have been 70 feet in depth previous to the floods of 1891 and 1895, which partially filled it. I have no authentic testimony as to the truth of this statement.

There are other lagoons in the channel that extend

down the river toward the Old Mission Dam. From the lower end of these lagoons a small stream of water is running at the present time, viz: November 19, 1904.

PROPOSED ENVELOPMENTS OF 1904-1905.

After the heretofore described investigations had been made and reports submitted by C. S. Alverson and J. B. Lippincott, approved by the Common Council of the City of San Diego the following general plan of development and purchase was submitted to the people July 23, 1905 and defeated.

First: The purchase of some 2100 acres of land for the sum of $73,000 and covering the entire length of the river channel and adjoining section from the west line of the Fanita Ranch to a point near Lakeside, and thereby controlling the underground water supply.

Second: The sinking of wells and erection of a main pumping plant near the Fanita Ranch house and afterwards extending the auxiliary wells up the river as required by the increased amount of water used.

Third: The construction of a distributing reservoir and the necessary water mains to convey the water to University Heights reservoir in San Diego.

The low cost of the necessary landsto control the underground supply and the small cultivated area along the river made it a feasible proposition at that time provided the quality of the water was sum that it would be proper for municipal use.

The examinations as to quality were meager at that time and with which I had no connection.

At the present time your office is in possession of

tests made by competent analytical chemists that have an important bearing on this subject.

ELEVATIONS ALONG SAN DIEGO RIVER TAKEN IN 1904
LEVELS TAKEN NOV. 10-12, 1904
DATUM CUYAMACA & EASTERN RAILWAY SURVEY
NOT REDUCED TO U.S.G.S DATUM.

Elevation top of rail at Santee Station (assumed)	364.00
Ground Elevation at Williamson's windmill	344.00
Elevation water surface " "	332.50
Elevation ground surface at Well No. 12	341.00
Elevation water surface at Well No. 12	332.00
Elevation ground surface at Gillen's pumping plant	333.50
Elevation center centrifugal pump Gillen's plant	324.50
Elevation water surface not pumping " "	320.50
Elevation surface of ground at Well No. 2	332.00
Elevation surface of water " " " "	324.00
Elevation surface of ground at " " 1	331.50
Elevation surface of water " " " 1	324.00
Elevation surface of ground at Vanita windmill near NW corner of Williamson tract	335.00
Elevation surface of water at above	319.50

PUMPING PLANTS ON SAN DIEGO RIVER
EXAMINATION MADE IN JULY, 1912.

E. W. SCRIPPS PUMPING PLANT NO. 1

Located on the right bank of the San Diego River on Sycamore Canyon road about 2½ miles westerly from Santee Railway Station described as follows: 16 HP gas engine; 3½ inch centrifugal pump, 6-inch suction, 6-inch discharge. Five 8-inch diameter wells from 22 to 26 feet in depth when they come to a hard compact marl or clay. Pumps about 450 gals. P. M. Commencing April 15th they averaged about 10 hours a day for 6 months. Equals 6,480,000 cu. ft. or 150 acre feet.

Note: Charles H. Lee in his reppрt of July 16, 1914, describes a well that has been driven just north of this, viz:

one 8 inch diameter well, 80 feet in depth; log as follows:

12 feet of adobe soil
28 feet of white soaky marl or clay
50 feet of blue gritty marl or clay, very hard

E. W. SCRIPPS PUMPING PLANT NO. 2
EXAMINATION MADE JULY 6, 1912

Located on the bottom land about 1½ miles westerly from Santee Railway Station. This was the main plant at that time as it also is at the present time. Description : 60 HP vertical 3-cylinder gas engine (Union), a 10-inch centrifugal pump (American) belt connected. Eight 6-inch drive wells equipped with Cook points and 26 feet in depth. Wells about 100 feet apart. Last well 714 feet from engine house. Pumping about 1800 gals. P.M. Expect to average about 10 hours per day for 6 months. Equals 25,920,000 or 600 acre feet.
Note: They have since dug nine 8-inch wells running due north from the pumping plant. Depth 26 to 30 feet. Log of wells: medium to fine sand; bottom of wells all on marl or clay. Water stands about five feet below surface. They also sunk a well at the north end of the old line of wells, the log of which is as follows:

30 feet of sand
8 feet of sand and marl
135 feet of marl or clay

I have no record of the present quantity being pumped.

H. D. WILLIAMSON'S PUMPING PLANT
EXAMINATION MADE JULY 6, 1912

Located about one-half a mile northwesterly from Santee Railwoad Station, near the left bank of the high water channel.

35 HP Dynamo, belt connected to an 8-inch centrifugal pump. Vacuum guage not running 14 inches when running 22 inches. Six 8-inch drive wells equipped with Cook points. Log of wells:

27 ft. of fine sand, silt and coarse sand
13 ft. of loosely cemented cobblestones

Pumping about 1800 gallons PM Expect to average 8 hours per

day for six months. Equals 20,736,000 cubic feet or 476 acre feet Irrigates about 100 acres. Plant installed in January, 1912. Note: This well is now the property of W. H. Dupee.

KINNEY & CHIESY PUMPING PLANT
EXAMINATION MADE JULY 6, 1912.

This is the old "North Side Pumping Plant of 1904."

Located on the right bank of the river about 3/4 of a mile north of Santee Railroad Station.

20 HP gas engine (Morse-Fairbanks) 6-inch centrifugal pump. Four wells at present about 40 feet deep. Two more to be put in. Vacuum guage not running 7 inches when running 20 inches. Pumps about 900 gallons PM Average time pumping about 10 hours per day for six months. Equals 12,960,000 cu. ft. or 300 Acre Feet. Irrigates at present 50 acres. Will irrigate 150 acres more.

MR. KINNEY'S SECOND PUMPING PLANT
EXAMINATION MADE July 6, 1912.

Located on the flat about 1000 feet NE of Santee Station. 6 HP gas engine; 3-inch centrifugal pump. Only one curbed well four feet in diameter and 20 feet deep. Water 8 feet below the surface of ground. When pumping 180 gallons PM lowers surface of water three feet. Average of 10 hours per day six months. Equals 2,592,000 cu. ft. or 60 acre feet.

JAS. BALLENTINE'S PUMPING PLANT
EXAMINATION MADE JULY 6, 1912.

This is the old "South Side Pumping Plant of 1904."

Located about 2500 feet N and E pf Santee Railroad Station. 30 HP dynamo and 8-inch centrifugal pump. Five 8-inch drive wells and 6-inch casing with Cook points. Wells

from 31 to 40 feet in depth. Vacuum gauge when pumping 20 inches. Pumps about 1575 gallons P. Average time pumping, 6 hours per day for 6 months. Equals 13,608,000 cubic feet or 312 acre feet. Irrigates 35 acres and has 165 acres more to irrigate.

J. JOHNSTON, JR., PUMPING PLANT

EXAMINATION MADE JULY 6, 1912.

Located about 800 feet NW of Riverview Railroad Station. 40 HP gas engine, belt connected to 8 inch centrifugal pump. Speed of engine, 240 revolutions PM Speed of pump 640 revolutions PM Eight 12-inch drive wells with 6-inch casing from 60 to 80 feet in depth, and about 60 feet apart. Pumps about 2700 gallons PM Average 10 hours per day 6 months. Equals 38,880,000 cu. ft. or 900 acre feet. Irrigates about 100 acres. Intends to irrigate about 225 acres more next year.

Log of wells: 5 feet of river sand; 5 feet of fine silt, 50 feet of sand and gravel (water bearing) 20 feet of partially cemented conglomerate. Log of all wells similar.

LAKESIDE FARMS PUMPING PLANT NO. 2
EXAMINATION MADE JULY 6, 1912.

Located on Lot 121 of Lakeside Farms sub-division. 35 HP gas engine; belt connected to a 7-inch centrifugal pump. Four 12-inch drive wells, 70 feet in depth, perforated 35 feet from bottom of well. Vacuum 17½ to 22 inches.

Pumps 1270 gallons PM Average 10 hours per day for six months. Equals 18,144,000 cu. ft. or 442 acre feet.

Engine consumes 3 gallons of stove distillate per hour when pumping about 900 gallons PM.

LAKESIDE PUMPING PLANT NO. 1

EXAMINATION MADE JULY 6, 1912.

Located on Lot 6 of Lakeside Farms Sub-division near the right bank of the high water channel of the river. 55 HP gas engine; 6-inch centrifugal pump for low service and a 10 x 10 Triplex pump for high service reservoir. Vacuum when pumping 18 inches. Water about four feet below surface. Centrifugal pump with 460 revolutions PM Pumps 1260 gallons PM. Triplex pump with average speed pumps 450 gallons PM. Average 10 hours per day 6 months. 1710 gallons P.M. and average 5 hours balance of year. 450 gallons PM or total 27,864,000 cu. ft. or 640 acre feet. Intends to irrigate 710 acres.

High service reservoir capacity 200,000 gallons. Static head 144 feet. Six new 12-inch drive wells from 48 to 83 feet in depth.

Log of wells (Also see diagram of same)

Approximate Elevation of Suction Main 390 feet A.S.L.

Well No. 1

Located on right bank of high water channel.

45 feet of fine sand and silt
15 feet of black tight clay
10 feet of yellow coarse gravel and sand
2 feet of decomposed granitic material
72 feet total depth.

Well perforated up twelve feet with five 8 inch slots per foot. When tested with 4-inch pump yielded 135 gallons PM on 25 foot draft.

Well No. 2

Located 200 feet south of No. 1

45 feet of fine sand and silt
12½ feet of black tight clay
12½ " of yellow coarse sand and gravel
4 " of decomposed granitic material
74 feet total depth.

When tested yield about 225 gallons PM.

Well No. 3

Located 150 feet southeasterly from No. 2

5 feet of fine silt
50 feet of good water bearing sand
10 feet of clay and some gravel
5 feet of decomposed granitic material
70 feet total depth

Perforated up 45 feet from bottom.

When tested yielded about 450 gallons PM

Well No. 4

Located 75 feet southeasterly from No. 3

7½ feet of fine silt
70 feet of coarse water bearing sand
4½ feet of yellow gravel
1½ feet of decomposed granitic material
83½ feet total depth

Perforated up 45 feet from bottom.

When tested yielded all a 4-inch pump would draw, about 900 gallons PM Lower water surface only 6 feet when pumping. Note the absence of the clay strata in this well.

Well No. 5

Located 75 feet southeasterly from No. 4

50 feet of coarse sand
5 feet of black clay
3 feet of yellow coarse gravel
1 foot of decomposed granitic material
59 feet total depth.

Perforated up 45 feet from bottom

When tested yielded 540 gallons PM. Lowered water surface 9 feet.

Well No. 6.

Located 75 feet from No. 5

Close to right bank of low water channel of river.

48 feet of coarse water bearing sand.

When tested yielded 450 gallons PM same as No. 5.

THEODORE HARNEE PUMPING PLANT

EXAMINATION MADE JULY 5, 1912.

Located about 700 feet west of the Lakeside Wagon bridge and near the right bank of the river. 20 HP Dynamo and a 6-inch centrifugal pump. The water supply is taken from an excavation about 40 feet diameter. Water surface three feet below surface of river bed. Water seven feet deep. Pumps about 765 gallons P.M. Average five hours per day for six months. Equals 5,508,000 cu. ft. or 126 acre feet.

HUGO THUM'S PUMPING PLANT

EXAMINATION MADE JULY 6, 1912.

Located on left bank of the San Diego River about 425 feet down stream from U. S. Gauging Station. 25 H. P. gas engine, 5-inch centrifugal pump for low service and a 6 x 10 Triplex pump for high service, both belt connected. Three 8-inch drive wells about 50 feet apart and 80 feet in depth. Pumps about 1035 gallons PM average 4 hours per day for 6 months. Equals 5,960600 cu. ft. or 136 acre feet.

Note: At same time, viz: July 6, 1912, at 2 PM found about 10 Miner's inches running on surface at U. S. Gauging station.

JOHN H. GAY'S PUMPING PLANT

EXAMINATION MADE JULY 6, 1914.

Located about 1300 feet northwesterly from the "Old Steam Plant" (See page 12) and near left bank of River 35 HP gas engine; belt connected to an 8-inch centrifugal pump Four 12-inch drive wells about 50 feet in depth. Vacuum 15 to 25 inches. Pumps 1575 gallons PM average 10 hours per day for 6 months. Equals 22,680,000 cu. ft., or 526 acre feet. Irrigates 55 acres.

L. J. MELVILLE'S PUMPING PLANT.

EXAMINATION MADE JULY 6, 1914.

Located about 800 feet west and north of the "Old Steam Plant" and near left bank of the river. 10 H. P. gas engine and 4-inch centrifugal pump. Two 10-inch drive wells, 30 feet in depth, water five feet below surface. Pumps 540 gallons PM average 10 hours per day for 6 months. Equals 7,776,000 cu. ft. or 178 acre feet.

Note: Lowers when pumping about 11 feet below water surface.

W. H. CHASE'S PUMPING PLANT

EXAMINATION MADE JULY 23, 1912.

Located 900 feet NW from U. S. Gauging Station. 12 HP gas engine (Union) and 5-inch centrifugal pump (American) Two 8-inch drive wells about 30 feet in depth. Draws down about 17 feet to pump 540 gallons PM Pumps about 1,306,800 cu. ft. or 30 acre feet. Irrigates about 7 acres; to irrigate 8 acres more.

J. M. PHILBROOK'S PUMPING PLANT.

EXAMINATION MADE JULY 6, 1912.

Located about 600 feet north of U. S. Gauging Station. 12 HP gas engine and 4-inch centrifugal pump. One curbed well with two points in bottom about 25 feet in depth. Pumps 450 gallons PM Estimated amount pumped. Equals 3,049,200 cu. ft. or 70 acre feet. Irrigates 28 acres and has about 12 acres more to irrigate.

G. E. PHILBROOK'S PUMPING PLANT
EXAMINATION MADE JULY 23, 1912.

Located about 1200 feet N & W of U. S. Gauging Station. 6 H. P. gas engine (West Coast) 4-inch centrifugal pump. One curbed well, 7 feet in diameter, 19 feet deep, 9 feet to water surface. Pumps 360 gallons PM Average ~~M~~ 4½ hours per day for six months. Equals 2,332,800 cu. ft. or 53.5 acre feet. From this plant irrigates about 25 acres.

SECOND PUMPING PLANT

He has a second pumping plant a short distance to the west of this which pumps about 225 gallons PM. Equals 1,306,800 cu. ft. or 30 acre feet. Irrigates about 10 acres.

JAMES WILLIAMS PUMPING PLANT
EXAMINATION MADE JULY 23, 1914.

Located 75 feet east railroad and one mile north of Lakeside. This is on the San Vicente drainage. 6 HP gas engine and 3-inch centrifugal pump. Curbed well 7 feet in diameter. Struck marl or clay about 25 feet below surface. Water stands 8 feet below surface of the ground. Also a windmill and pump about eight feet east. Pumps about 225 gallons PM estimated quantity per annum. Equals 980,100 cu. ft. or 22.5 acre feet. Irrigates about 10 acres of bottom land.

L. KIRKPATRICK'S PUMPING PLANT

EXAMINATION MADE JULY 23, 1912.

Located 3/4 mile north of Lakeside. 5 HP gas engine and 3-inch pump; one 8-inch drive well 28 feet deep and still in good material. Pumps about 225 gallons PM Estimated quantity per annum equals 980,100 cu. ft. or 22.5 acre feet. To irrigate 10 acres of land.

J. C. BROCKWAYS PUMPING PLANT
EXAMINED JULY 23, 1914.

Located on right bank of river 500 feet up stream from Lakeside bridge. 5 HP Dynamo and 2½ inch pump. One well with 3-inch casing and 30 feet in depth. Estimated quantity equals 643,400 cu. ft. or 15 acre feet. Irrigates six acres.

DR. LEARN'S PUMPING PLANT
EXAMINED JULY 23, 1914.

Located 75 feet south of railroad and 800 feet west of Riverview Station. 7½ HP motor and 4-inch centrifugal and small triplex pump. Three 6-inch drive wells with Cook points. Pumps 270 gallons PM. Equals 871,200 cu. ft. or 20 acre feet.

Irrigates 10 acres. Will irrigate 15 acres more.

Notes: These are the plants that I examined.

APPROXIMATE AREA IRRIGATED IN 1912 aAND ADDITIONAL

AREA PROPOSED TO BE IRRIGATED ALONG SAN DIEGO RIVER

Owners & Location	Acres Area Irrigated	Additional area to irrigate	Estimated Acre feet Pumped in 1912
MONTE VALLEY			
The Monte Ranch	15	0	90
John H. Gay	55	70	526
J. H. Birch	0	12	0
Ira Philbrook	0	42	0
- - Ireys	0	150	0
Total	70	274	616
LAKESIDE VALLEY			
G. G. Nelson	0	40	0
J. M. Philbrook	28	12	70
G. Philbrook	35	0	83.5
L. J. Melville	25	15	178.
Jas. Williams	10	0	2225
A.H. DeGaston	0	5	0.
L. Kirkpatrick	4	6	22.5
J. C. Brockway	6	0	15.
- - McClam	10	30	25.
Whittaker & Langton	10	25	25.
Griffin & Thompson	18	450	45.
Hugo Thum	40	60	136.
Theodore Barnes	75	0	126.
H. W. Chase	6	8	30
J. Johnston, Jr.	100	225	2900.
Lakeside Farms No. 2	180		442.
Lakeside Farms No. 1	200	330	640.
Total	747	1206	2760.
ELCAJON VALLEY			
Dr. Learn	10	15	20
Jas Bellantine	35	165	312
- - Kinney	10	0	60
Kinney & Chelsey	50	150	300
H. D. Williamson	85	365	476
E. W. Scripps No. 1	20		150
E. W. Scripps No. 2	65	1915	600
Total	275	2610	1918
GRAND TOTAL	1043	4090	5294

APPROXIMATE AREA OF BOTTOM & MESA LAND
IRRIGABLE FROM GROUND WATER BASINS IN
THE VALLEY OF THE SAN DIEGO RIVER

Taken from Charles N. Lee's Report of September, 1912, and from personal observations.

Values in Acre Feet

Ground Water Basin	Area Bottom Land	Irrigable Bottom Land	Irrigable Los Mesa Lands	Area Irrigated 1912	Area to be irrigated in future
Cape Horn to Monte Contraction	880	750	0	15	0
Monte Contraction to U.S.Gauging Station	425	360	0	55	274
U.S.Gaug. Sta. to Riverview Contraction	1150	975	(880)	708	1185
Riverview Contraction to Old Mission Dam	2500	2125	1500	255	2699
San Vicente Basin	704	650		207	565
Los Coches Basin	128	115		115	

Note: (By C. S. Alverson) It must be taken into consideration that of the lands to be irrigated in the future there is considerable area that will not be irrigated for some time and some not in a life time if ever.

This fact should be taken into consideration if the City of San Diego concludes to purchase the riparian rights and water systems along the San Diego River.

Also a portion of the Lakeside Farms lies on the high slopes to the north of the river and cannot be classed as bottom lands.

SURFACE RUN OFF OF STREAMS FOR UNDERGROUND SUPPLIES.

There has been considerable discussion pro and con in reference to what effect the additional development of a water supply, and the construction of dams for the storage of a portion of the floods of the upper section of the San Diego River would have on the underground supplies below now being used for irrigation.

The records show that in years when the rainfall is above normal that large quantities of water run unused to the ocean and benefit no one.

Also that not less than 90 per cent. of the rainfall in this section of the country falls during the six months from November to April inclusive, and 75 per cent. in a period of four months. The effect of such a condition can readily be seen by those who have made a study of this subject. The effect is entirely different than in a section where the snow and rainfall is distributed during the entire year.

Investigations show and practical common sense proves that in periods of drouth where the rainfall is far below normal that little benefit to underground storage is obtained from the surface run-off and that the benefits derived by the filling of the sands and gravels in these basins from the maximum run-offs has long since disappeared. And this is true whether the water has been artificially extracted or allowed to sink to a lower level of saturation and lost. The following tables and date show the result in the past, and what we may expect in the future unless practical and scientific remedies are applied. And this can be done only after a careful and thorough investigation.

APPROXIMATE GRADE OF BED OF SAN DIEGO RIVER

Elevation in Feet, Datum, Mean Sea Level, Distance in Miles

Location	Elevation River Bed	Distance Miles	Grade Ft. per Mi.
Bridge at Old Town	6	0	
E. Line Pueblo Lands	44	4.4	8.6
Loop Dam Site	182	7.3	19.0
Old Mission Dam	275	1.6	58.1
Riverview Contraction	368	5.7	16.3
Lakeside Guaging Sta	408	3?1	13.0
Monte Contraction	440	1.3	24.6
Cape Horn Point	530	3.5	25.7
El Capitan Dan Site	605	2.5	30.0
Mouth South Fork	635	1.75	17.1
Diverting Dam	800	6.50	10.0

Total Bridge to Diverting Dam - 37.65 miles

AREA OF WATERSHED.

		Sum Total Sq.Mi.
Boulder Creek above Cuyamaca Dam	12	
Boulder Creek to Mouth	23	
Cedar Creek to Mouth	27	
North Fork to Mouth	40	
San Diego proper to Diverting Dam	2	104
South Fork Branch to Mouth	37	
Chocolate Creek to Mouth	17	
San Diego proper to El Capitan Dam	33	191
San Diego proper to U. S. Gauging Station	17	208
San Vicente Creek to Mouth	71	
Los Coches Creek to Mouth	16	
San Diego proper to Old Mission Dam	81	376
Mission Dam to S. D. Pueblo Line	53	429
S. D. Pueblo Line to Bridge at Old Town	11	440

RAINFALL DATA, SAN DIEGO COUNTY, CALIF.

	San Diego City Elv.Gauge 93Ft.	Sweetwater Dam Elv.Gauge 250Ft.	Ramona Elv.Gauge 1440 Ft	Cuyamaca Dam + Elv.Gauge 4643 Ft.
	Inches	Inches	Inches	Inches
1898-99	5.24	5.84	8.05	26.25
1899-1900	5.97	6.50	13.05	28.79
1900-01	10.45	9.24	13.72	42.81
1901-02	6.17	7.06	10.35	36.00
1902-03	11.76	10.45	16.61	36.59
1903-04	4.40	5.11	8.21	23.37
1904-05	14.32	15.36	28.60	57.89
1905-06	14.68	16.68	28.65	56.24
1906-07	10.62	13.08	20.80	44.91
1907-08	8.55	10.51	17.30	30.35
1908-09	10.23	12.09	18.05	46.65
1909-10	9.79	10.29	18.57	33.44
1910-11	11.99	11.27	16.95	32.15
1911-12	10.73	11.50	19.30	31.90
Period of 14 years	134.92	144.98	237.65	527.34
Annual Average	9.64	10.36	16.97	37.67

+ The above table of precipitation at Cuyamaca includes for the first time the snowfall (10 inches of snow equals 1 inchesof rain); previous tables up to 1903 did not include the snow.

AVERAGE PRECIPITATION AND RUNOFF FROM DRAINAGE AREA TRIBUTARY TO SAN DIEGO RIVER

Period from 1898-99 to 1911-12 inclusive.

	Area Sq.Mi.	Mean Annual Precipitation Inches	Mean Annual Precipitation Acre-Ft	Mean Annual Runoff Acre-Ft.	Per cent Runoff to Rainfall
Drainage Basin above the Cuyamaca Dam	12	37.67	24,108	4,270	17.7
Cuyamaca Dam to Diverting Dam	92	27.0	132,479	11,997	9.1
Diverting Dam to U.S.Gauging Stn.	104	19.5	108,000	8,270	7.6
U. S. Gaug. Sta to Old Mission D am	168	12.5	121,000	6,320	5.2
Old Mission Dam to Murray Canyon	55	10.	29,300	879	3.0
San Vicente Creek	71	15.6	59,100	4,020	6.8
Los Coches Creek	16	13.8	10,900	660	6.0

SURFACE RUNOFF FROM THE SAN DIEGO RIVER

Season	Above Cuyamaca Dam Area 1259 Sq.Mi. Acre Feet	Cuyamaca Dam to Diverting Dam, Area 92 Sq.Mi. Acre Feet	Diverting Dam to El Capitan Dam, Area 87 Sq.Mi. Acre Feet	El Capitan Dam to U. S. Gauging Sta Area 17 Sq. Mi. Acre Feet	Total for 208 Sq. Mi. Acre Feet.
1898-99	472	1033	605	120	2230
99-00	260	655	260	50	1225
1900-01	3030	4360	3517	680	11587
01-02	2350	4555	2332	445	3682
02-03	2516	8375	2590	491	13972
03-04	492	986	515	100	2093
04-05	6830	22065	12088	2360	43343
05-06	12775	33390	26302	5100	77567
06-07	9260	29945	14996	2970	57171
07-08	3200	12632	5310	1025	22167
08-09	7175	20760	11380	2210	41525
09-10	5135	13630	7100	1380	27245
10-11	2765	8324	4537	780	16406
11-12	3520	7256	3950	774	15500
Total	59780	167966	35482	18485	341718
Average per year	4270	11997	6820	1320	24408
Mean per Sq.Mile	356	130.4	78.4	77	117.3

DISCHARGE SAN DIEGO RIVER AT DIVERTING DAM

AND AMOUNT DIVERTED BY FLUME AT THAT POINT.

Season	Area 104 Sq.Mi. Acre Feet.	Diverted into the Flume. Acre Feet ♦	Lost in Overflow Stream Bed and Evaporation Acre Feet.
1898-99	1505	1218	287
1899-1900	915	665	250
1900-01	7390	2584	4806
1901-02	6806	2964	3841
1902-03	10891	3854	7037
1903-04	1478	1334	144
1904-05	28895	2808	26087
1905-06	46165	6140	40025
1906-07	39205	5605	33600
1907-08	15832	6920	8912
1908-09	27935	5822	22113
1909-10	18765	5812	12953
1910-11	11089	6228	4861
1911-12	10776	3544	7232
Total	227746	55598	172148
Mean per Annum	16237	3971	12296

♦ A portion of the water diverted was used to fill the La Mesa Reservoir and a considerable part of it was lost from leakage in the flumes and conduits.

AVAILABLE SURPLUS AT THE DIVERTING DAM.

On the Assumption that the Diverting Dam is raised 50 feet, with a Storage Capacity of 2600 Acre Feet, and 4400 Acre Feet diverted per Annum for Distribution along the line. Cuyamaca to furnish 2200 Acre Feet on an Average, and 2200 Acre Feet from the 92 Square Miles Below.

ASSUMING RESERVOIRS ARE EMPTY JULY 1, 1898.

Season.	Total Runoff.	Total Evaporation.	Diverted into Flume	Amount in Storage	Surplus Overflow
1898-99	1505	287	1218	None	None
1899-1900	915	250	665	"	"
1900-01	7390	1080	4400	1090	"
1901-02	6805	2160	4400	1335	"
1902-03	10891	2160	4400	5666	"
1903-04	1478	2160	4400	584	"
1904-05	23395	2160	4400	7260	17050
1905-06	46165	2160	4400	14000	33205
1906-07	39205	2160	4400	14000	32640
1907-08	15832	2160	4400	12800	10220
1908-09	27935	2160	4400	14000	21120
1909-10	18765	2160	4400	14000	12120
1980-11	11080	2160	4400	13320	5914
1911-12	10776 V	2160	4400	12440	4845
	227746	25377	50283		135900

RUNOFF ABOVE EL CAPITAN DAM

TOTAL AREA OF WATERSHED - 191 Square Miles.

Assume the El Capitan is constructed Capacity 20,000 Ac Ft. Diverting Dam is constructed Capacity 2,600 Ac. Ft. Cuyamaca Reservoir Capacity 11,400. Total Storage Capacity 34,000 Ac Ft.

Assume 4,400 Ac. Ft. diverted for consumption along the line.

Assume Reservoirs are empty July 1, 1898.

Values Given in Acre Feet.

Season	Total Runoff	Total Evap'n.	Diverted 4400 Ac.Ft.	Stored in El Capitan	Surplus Wasted.
1898-99	2230	-	-	500	None
1899-1900	1225	-	-	700	"
1900-01	10907	1800	4400	3400	"
1901-02	2235	3600	4400	4300	"
1902-03	13481	3600	4400	5450	"
1903-04	1933	3600	4400	3350	"
1904-05	40983	3600	4400	20000	11050
1905-06	72467	3600	4400	20000	64450
1906-07	54201	3600	4400	20000	46000
1907-08	21042	3600	4400	20000	13000
1908-09	39315	3600	4400	20000	31300
1909-10	28565	3600	4400	20000	27850
1910-11	15626	3600	4400	20000	7550
1911-12	14726	3600	4400	20000	6600
Total	323246				197800

Mean Annual Evaporation at Cuyamaca Reservoir - 1950 Ac. Ft.

" " " " Diverting Dam " 210 " "

" " " " El Capitan " 1440 " "

Sum total- - - - - 3600 " "

AVAILABLE DAM SITES ON THE SAN DIEGO RIVER AND BRANCHES.

The following description of the dam sites on the San Diego River and its branches, is compiled from personal surveys and examination and other sources of information. Elevations given are (approx.) reduced to U. S. Geological dates. Elevations per City datum would be six feet and lower.

LOOPEDAM SITE

Located on the San Diego River about 1-1/2 miles below the Old Mission Dam, in a rocky gorge.

Elevation of river bed or 0 contour 182 feet above sea level.

The south side and bottom is good solid bed rock. The North side is more of a broken ledge and boulder formation.

The distance across the bottom is 130 ft. at 50 feet contour 400 ft. and at 100 ft. contour 650 feet. The estimated cost for a solid masonry dam with overflow section is over $400,000.

I have made no estimate of the storage capacity of the reservoir. T. M. Loop in 1894 estimated its capacity to be 2 billion gallons at 100 foot contour. One objection would be its elevation. It would require about 10 miles of pipe line and a tunnel over a mile long to deliver the water into the City Park at an elevation of about 150 feet above sea level. This is on the supposition that the outlet is at an elevation of 200 feet. When the reservoir storage was above that elevation, then there would be an additional head up to surface of water in reservoir, is also true.

The foundation for the dam is partially completed.

LA MESA IRRIGATION DISTRICT DAM SITE.

Authority - T. B. Lippincott

Location - About 1500 feet down stream from the Old Mission Dam, or about 700 feet below west boundary line of El Cajon Grant.

Elevation 0 contour - 244 feet above mean sea level.

" Top of Dam, 347½ " " " " "

Width of Canyon at Base - 28P feet

" " " " Top - 575 "

Area flooded at top of dam - 1675 Acres.

Capacity of Reservoir Full - 34,000 Acre Feet.

(Note by C. S. A.) Total area of watershed about 378 Sq. Mi.

The flooded land would extend up to about 4000 feet below the Riverview contraction.

This may be a good proposition for the La Mesa Irrigation District and not for the City of San Diego.

OLD MISSION DAM.

Located at head of gorge at lower end of the North El Cajon Valley. This dam was built by the "San Diego Mission Fathers" about 1776, or 138 years ago. It is a low masonry structure from 8 to 10 feet in thickness. The bed rock in the bottom of the stream, and on the north side up to about 50 feet elevation is excellent. On the south side of left bank there is some boulders and earth on the surface and would require some excavation.

Elevation 0 Contour of Dam - 275 feet above sea level

" Top of Fifty Ft. Dam, 325 " " " "

Width of Canyon at Base of Dam, 275 feet

" " " " Top " " 600 feet

Area flooded at 25 ft contour, 140 acres

" " " 50 " " 730 "

Capacity of Reservoir Full (Approx.) 12,700 acrem feet

Total Area of Watershed above Dam Site, 376 Square Miles.

EL CAPITAN DAM SITE.

Located about 1/2 mile below mouth of Chocolate Creek.

Elevation 0 Contour of Dam, 605 feet above Sea Level.

" 100 " " " 705 " " " "

" 125 " " " 730 " " " "

Capacity of Reservoir, Authority W. E. Post.

Contour	Acres Flooded	Acre Feet	Million Gallons
10	15	307	100
20	46	614	200
30	76	1228	400
40	107	1995	700
50	153	3378	1100
60	200	5220	1700
70	260	7360	2400
80	353	10430	3400
90	475	14400	4700
100	615	20000	6500
110	720	26700	8700
120	800	34400	11200
125	820	38300	12500

Total Area of Watershed above Dam, 191 square miles.

DIVERTING DAM PROPOSED RESERVOIR.

Located about 1/2 mile below mouth of Boulder Creek and is present head of Cuyamaca Water Company's main flume. Masonry dam built in 1887. Raised to Elv. 826 ft. in 1912.

Elevation 0 Contour of Dam, 792.5 ft. above sea level

" Botton Scouring Gate, 799.5 " " " "

" Present Flume Floor, 812.5 " " " "

" " Bottom of Spillway, 822.0 ft.

" Top of Dam, 826.2 ft.

Capacity of Proposed Reservoir.

Contour	Acres Flooded	Capacity Acre Feet	Million Gallons	
20	2	2		present Flume Floor
30	10	69	12	Present Top of Dam.
40	24	200	65	
50	40	640	208	
60	58	1140	372	
70	74	1715	559	
80	93	2600	847	
90	123	4480	1471	
100	157	6000	1955	

Total Area of Watershed above Dam, 104 square miles.

(Note) It is proposed to utilize the existing dam for the water face up to its present height, viz. 30 feet contour. The remaining section to be a hollow reinforced concrete over flow Dam

LAKE HELENA DAM SITE

Located on the North Fork of the San Diego River just below junction of Cedar Run and about 1-1/2 miles above the Diverting Dam.

Approximate Elevations as follows;

Elevation 0 Contour of Dam, 860 ft. above sea level

" 150 " " " 1010 " " " "

" 155 " " " 1015 " " " "

Width of Canyon at Base of Dam, - 190 feet.

" " " " Top " " 1100 "

Area flooded at 150 ft. contour - 226 Acres.

Capacity at 150 ft. contour 688,821,500 cu.ft. or 15813 Ac.Ft

Total Area of Watershed above Dam Site 67 square miles

Mean annual runoff equals 130.4 x 67 sq.mi. equals 8737 Ac.Ft

The proposed method of constructing the dam is by hydraulicing, similar to that used in building the "La Mesa Reservoir No. 3". There is plenty of material at hand. Cedar Run Creek and Boulder Creek will furnish a good water pressure to hydraulic the material that will be placed in the dam. With top of 25 feet and 2-1/2 on 1. water face slope and 1-1/2 on 1 down stream slope, it would require about 782,000 cubic yards of material in the dam proper.

Sounding for foundation and further investigations would be necessary before final adoption of this location.

CUYAMACA DAM AND RESERVOIR

Located on Boulder Creek near N.E.Cor. Sec. 5, T14 S., R. 4 E. Original structure 35 ft. in height was completed in February 1887. In 1895 it was raised to 41.5 feet with floor of spillway at 35 feet.

Elevation 0 Contour at Dam, 4595 feet above sea level

" 35 " Spillway, 4630 " " " "

Area of Watershed above Dam, - 12 sq. miles.

Contour	Acres Flooded	Capacity Acre Feet	Million Gallons.
12	61	80	26
15	144.3	357	126
18	265.3	900	325
20	343.6	1520	523
22	434.5	2290	776
24	523.0	3240	1085
26	607.4	4360	1457
28	687.6	5650	1871
30	767.8	7100	2342
31	806.0	7970	2597
32	844.3	8710	2864
33	882.6	9647	3143
34	920.8	10470	3435
35	959.7	11400	3736

Data from records kept at Cuyamaca Dam.

Mean rainfall from 1888 0 96 inclusive 0 44.23 inches
" runoff in Acre Feet - - - - - - 5397 Acre Feet
" Per cent of runoff to Precipitation 19.83 Per cent
" Evaporation per annum in depth - - - 4.73 Feet
Average Draft from Reservoir per annum -4331 Acre Feet

LA MESA RESERVOIR NO. 3.

Dam located in SW 1/4 Sec. 13, T. 16 S., R. 2 W. on the north branch of Alvarado Canyon and about 2 miles northwesterly from the City of La Mesa.

Elevation 0 Contour of Reservoir, 435 feet above sea level

" Center of Outlet Pipe, 438.5 " " " "

" Top of present dam, 805.5 " " " "

Area of Watershed above Dam, - 5 square miles.

Contour	Acres Flooded	Capacity Acre Feet	Million Gallons.
20	5	30	10
30	12	110	36
40	24	290	94
50	42	610	199
60	62	1130	388
65	70	1460	476
70	83	1850	603
80	113	2820	918
90	152	4120	1342
100	205	5920	1929

Hydraulic fill dam. Asphalt coating on water face. Built in the year 1895 by San Diego Flume Co. Leading out of the dam is a 24" in diameter wood pipe some 6350 feet in length which connects with the main pipe line to the City of San Diego at an elevation of about 457 feet.

This reservoir is filled from the flood waters brought down in the Cuyamaca Water Company's main flume, to which it is connected by a 36" dia. wood pipe and open ditch. This acts as a reserve supply.

OTHER RESERVOIR AND DAM SITES.

At the end of the main Cuyamaca Water Company's flume, located about 1/2 mile west of Grossmont, is a small reservoir, capacity at 25 ft. contour 8,228,000 gallons.

Murray Hill Reservoir near Grossmont Railway Station, has a capacity at the 24½ ft. contour of 43,558,400 gallons, and is used as an equalizing reservoir.

Returning to the upper branches of the San Diego River, there are several reservoir sites, known as Boulder Creek, Conejos Creek and Poverty Gulch etc., which I presume will be fully described in the report to be submitted to your department by the Cuyamaca Water Company.

The feasability and economic value of these reservoir sites depends on the future method of developing an increased water supply from the watershed of the San Diego River.

I have not taken up the subject of water development in Mission Valley, for the reason that your office is in possession of records and data extending over a period of more than 30 years; and for the further reason that you have been and are at the present time sinking wells and installing machinery under the bond issue of $200,000., and any additional data that I have would probably be of no material benefit to the Water Department.

CONCLUSIONS.

For more than a quarter of a century we have examined and investigated the San Diego River and its various branches from where its waters mingle with those of the Pacific Ocean to the crest of the mountain summits that divide the western slope from the Colorado desert. We see a river whose greater portion of waters run unelessly to the sea. We see adjacent and tributary to the same, thousands of acres of mesa and valley land that only needs the magic touch of water, labor and industry to make it produce abundantly. This has been only partially accomplished, why many of us know. We see a city with a great future, and at its feet a harbor that is destined to be an important factor in the commerce of the world. This city also is partially dependent upon the San Diego River for a supply of water, if it expects to keep pace with the other sections of the great commonwealth of California.

Our investigations also show that the residents of Mission Valley have their rights; that the ranchers of North El Cajon Valley, Lakeside and Monte have their rights; that the inhabitants of South El Cajon Valley, of La Mesa, Spring Valley, Lemon Grove and the territory bordering on the Pueblo of San Diego have acquired rights to the use of water from the San Diego River for a period of more than 25 years.

There can be no doubt that the prosperity and the upbuilding of the City of San Diego is the dominant factor in the development of this section of the country. It is also true that the other portions of the community above mentioned,

who have, with a liberal hand, spent their money, their time and their experience in an effort to develop the resources of this section and acquire a livelyhood, are also entitled to consideration, if for no other reason than that their prosperity is the prosperity of the City of San Diego.

The power that brought matter and force into existence, has created certain conditions over which we have no control. It therefore remains for us in a united, intelligent and scientific manner to utilize the forces of nature for our benefit, and for our guidance, we have the lessons of the past before us.

It then follows that the problem for us to analyze is how best we can conserve and utilize these waters that heretofore have run to waste.

In the above report, from personal investigations, the investigations of others and data obtained from reliable records, I have compiled tables showing the depth of rainfall at San Diego City, Sweetwater Dam, Ramona and Cuyamaca Dam. Also tables showing the annual and mean runoff or surface discharge of the San Diego River from 1898--99 to 1911-12 inclusive, and the amount of water developed and used. Also the location, capacity etd. of the various dams and reservoirs already constructed and the proposed dams and reservoirs, and also showing their relations to each other in the plan of proposed conservation.

The following conclusions are based on the assumption that the City of San Diego acquire the property of the Cuyamaca Water Company

LOOP DAM AND RESERVOIR SITE.

Located on the San Diego River about 1-1/2 miles below the Old Mission Dam. Area of watershed 379 square miles.

The elevation above sea level, the small storage and the cost of the dam make it an undesirable proposition.

LA MESA IRRIGATION DISTRICT DAM SITE.

Located about 1500 feet down stream from the Old Mission Dam. Area of watershed 378 square miles.

The elevation of this dam site is about 62 feet higher than the Loop Dam Site. The storage capacity is good, but the area flooded is large, and it receives the drainage from a cultivated and settled district, which tends to make it undesirable for domestic use. It is also a pumping proposition.

OLD MISSION DAM AND RESERVOIR SITE.

Located at head of gorge at lower end of North El Cajon Valley. Area of watershed 376 square miles.

The same objections apply to this as to the La Mesa Irrigation District's Dam.

The objections to the LoopeReservoir, the La Mesa Irrigation District Reservoir and the Old Mission Reservoir are not prohibitive to use the water for municipal purposes in the City of San Diego. At the same time, if a better quality of water and better results can be obtained by going farther up the river, it is desirable for the City of San Diego to embrace the opportunity.

EL CAPITAN DAM AND RESERVOIR SITE

Located about 1/2 mile below mouth of Chocolate Creek.

If investigations show that a safe and permanent overflow masonry dam, 100 feet in height, can be built at this point, the following alternative propositions could be adopted:

First: To raise the stored water into the present Cuyamaca Water Company's main aqueduct to an elevation of some 750 feet above sea level, by pumping as follows:

Water at	100	ft.	contour	-	Capacity	20,000	Ac.Ft.	Lift	45	ft.
"	"	80	"		"	10,430	"	"	65	"
"	"	50	"		"	3,378	"	"	95	"
"	"	40	"		"	1,995	"	"	105	"

This provides for 90% of the water stored in the reservoir; The water to be conveyed to the City of San Diego along the line of the present Cuyamaca Water Company's aqueduct or such other lines as may be determined in the future.

Second: This would be a gravity proposition from the El Capitan Reservoir to University Heights Reservoir. Commencing at the dam elevation of outlet pipe 625 feet above sea level; thence by pipe line to the south of Lakeside, Riverview and Santee, to a point above the Old Mission Dam a distance of some 16 miles. At this point construct an equalizing reservoir. Elevation top of dam 475 feet above sea level; thence by pipe line to University Heights Reservoir and additional distance of 9-1/4 miles.

If this plan was adopted and La Mesa Reservoir No. 3

was purchased, a pipe line some 2 miles in length would connect it with the above conduit a short distance to the east of Granville.

(Note) The advantages of La Mesa Reservoir No. 3, as a source of supply, will be hereinafter more fully described.

DIVERTING DAM RESERVOIR

Located about 1/2 mile below mouth of Boulder Creek.

It is proposed to raise this structure to the 80 ft. contour with a storage capacity of 2,600 acre feet, for the purpose of equalizing the flood waters. Increase the capacity of the present conduit to say 40 sec. ft., and during the winter months fill La Mesa Reservoir No. 3 for use in an emergency and during the period of heavy draft on the system.

LAKE HELENA RESERVOIR SITE.

Located on North Fork about 1½ miles above diverting Dam.

This is an alternative proposition to be constructed in case the El Capitan Dam is not considered feasible.

(See Page 43 for reference to capacity, etc.)

CUYAMACA RESERVOIR.

This reservoir having been in use some 25 years and the records showing its duty and capacity, no further description is necessary, except that the loss of from 20 to 35 per cent of the water turned out of the reservoir before it reaches the diverting dam, should be remedied by constructing a conduit on the lower section, similar to the one being constructed

between the Morena Dam and the Barrett diversion.

The other possible reservdr sites referred to on Page 47, can be investigated at the same time that the above described developments are being investigated.

LA MESA RESERVOIR NO. #.

(Described on Pages 45 to 50)

If the water supply of the San Diego River is developed along the lines heretofore described, this reservoir becomes an important factor in the distribution of the water.

If a conduit of some 40 Sec. Ft. capacity is constructed from the Diverting Dam to the end of the present main flume, and thence connected by present conduits or other methods, a portion of the surplus flood waters would fill it, and you would have a reserve supply of some 6,000 Acre Feet within less than 7 miles of the University Heights Reservoir.

As has been already stated, this reservoir is already connected by pipe and conduit lines with the present supply, and has at present a storage capacity of 1,460 Acre Feet stored at an elevation of 435 to 500 feet above sea level.

The table on Page 40 shows that if a storage of 2,600 acre feet is provided at the Diverting Dam and 4,400 ac.ft. per annum be taken for use along the line, that from 1903--4 to 1911-12 there would have been wasted down the river bed 135,200 acre feet of flood waters.

The table on page 41 shows that if a storage of 2600 acre feet at the Diverting Dam and a storage of 20,000 A.F. at the El Capitan Dam had been provided, and 44,400 A.F. per annum taken for use along the line, that from 1903-4 to 1911-12 there would have been wasted down the river bed 197,800 A.F. of flood waters.

If an additional 6,000 A.F. per annum had been diverted from the El Capitan, there would have still been 149,800 A.F. of surplus flood waters. 6,000 A.F. equals 1955 million gallons or 6 million gallons per day. Or if 10,000 A. F. had been diverted, the equivalent of 10 million gallons per day, there would still have been 117,800 A. F. of flood waters wasted down the river bed.

Trusting the above report will be of use to your department, I remain,

Respectfully yours,

(Signed) C. S. Alverson

Civil and Hydraulic Engineer.

San Diego Cal. - August 17, 1914.